REMARKS

Claims 1 to 14 and 21 to 26 were pending when last examined. Applicant has amended claims 1 to 4, 7 to 10, 12, 14, and 21 to 26, canceled claims 5, 6, 11, and 13, and added claim 27. Claims 1 to 4, 7 to 10, 12, 14, and 21 to 27 remain pending.

Background on Deformation

In solid mechanics, deformation is a change in shape due to an applied force. This can be a result of tensile (pulling), compressive (pushing) forces, shear, bending, or torsion (twisting) forces. The first plot of Fig. 8 of the present disclosure illustrates a typical deformation with a stress-strain curve under a tensile stress test, where the stress is the load experienced by an object and the strain is the extension (or compression) of the object. The second plot of Fig. 8 illustrates a curve of force against displacement.

When an object is elastically deformed, it will return to its original shape once forces are no longer applied. This is shown as the linear slope portion of the stress-strain curve. When an object is plastically deformed, its shape is permanently changed under the forces being applied. However, as the object has to first undergo elastic deformation before plastic deformation, the object will return part way to its original shape once forces are no longer applied. Plastic deformation is shown as the flat portion of the stress-strain curve. For example, when an object is plastically deformed beyond point C, it will still return part way to its original shape to point B but it cannot return all the way to its original shape at point A. The difference between points B and A is the permanent change in shape under plastic deformation.

Note that plastic deformation does not mean a material is made of plastic. Rather, it refers to a type of deformation experienced by the material and plasticity is a theory in the science of solid mechanics.

Brief Description of the Invention

In one embodiment, the claims recite a Land/Ball Grid Array (L/BGA) integrated circuit subsystem that includes (1) a bolster plate, (2) a PCB above the bolster plate, (3) a frame on the PCB, (4) a L/BGA socket on the PCB within the frame, (5) a L/BGA package on the socket within the frame, (6) an elasto-plastic stiffener on a substrate of the L/BGA package within the frame, and (7) a

heat transfer device (e.g., a heat sink) on the frame and pressing down on the elasto-plastic stiffener and a top surface of the L/BGA package (e.g., a top side of a semiconductor chip).

In one embodiment, the elasto-plastic stiffener that shares a pressure with a semiconductor chip in a package. The stiffener plastically deforms so it can conform to large vertical variations of elements above and below it. The stiffener also plastically deforms to set an upper bound for the stiffener's portion of the pressure, which in turn sets the semiconductor chip's portion of the pressure since the stiffener and the semiconductor chip share the pressure.

In another embodiment, the claims further recite that the L/BGA socket is an elasto-plastic socket with metal contacts. Each metal contact plastically deforms so it can conform to large vertical variations of elements above and below it. Each metal contact also plastically deforms to uniformly distribute another pressure to the L/BGA package.

In general, the present invention is different from the prior art in that the subsystem utilizes elasto-plastic stiffener and socket. The term "elasto-plastic" refers to the fact that the stiffener (more specifically a serpentine shaped support structure in the stiffener) and the socket (more specifically the metal contacts in the socket) undergo both elastic and plastic deformations, whereas the prior art only discloses elastic deformation. The benefits of plastic deformation include the freedom to select a material based on its ability to deform to a large extent before failing (fracturing). <u>This allows the stiffener and the socket to conform to greater variations in the components mounted above and below them.</u>

Plastic deformation also allows one to set an upper bound on the pressure being supported since elements of the same material will transfer substantially the same amount of force when they are under plastic deformation. This is illustrated in the stress-strain curve of Fig. 8, where the flat portion of the stress-strain curve shows that a material experiences substantially the same stress for a wide range of strain. <u>This allows the stiffener and the socket to support desired amount of the pressures. In the case of the stiffener, this also allows one to set a remainder of the pressure to be supported by the semiconductor chip in the L/BGA package since the stiffener and the semiconductor chip share the pressure.</u>

Plastic deformation further allows a uniform distribution of the pressure since elements of the same material support substantially the same amount of force when they are under plastic deformation. <u>This allows the socket to uniformly distribute another pressure to the L/BGA package.</u>

Claim Rejections

Claims 12 and 13

Applicant has amended claim 12 to include limitations similar to those found in claim 13. Applicant has canceled claim 13. Accordingly, Applicant addresses the Examiner's rejection of claims 12 and 13 together.

The Examiner rejected claim 12 under 35 U.C.C. § 102(e) as being anticipated by U.S. Patent No. 6,930,884 ("Cromwell et al."). The Examiner rejected claim 13 under 35 U.S.C. § 103(a) as being unpatentable over Cromwell et al. in view of U.S. Patent No. 6,545,879 ("Goodwin") and further in view of U.S. Patent No. 6,765,793 ("Kehret et al."). Specifically, the Examiner stated:

> Regarding claim 13, Cromwell et al. disclose the instant claimed invention except for the package assembly including at least one plastic stiffener formed on the top of the package.
>
> Goodwin discloses the package structure (figure 1) having a stiffener (60) being formed on the package structure.
>
> It would have been obvious to one of ordinary skill in the art at the time the invention was made to ad the stiffener on the top of the package assembly of Cromwell et al., as suggested by Goodwin, for the purpose of strengthening the package structure when the heat sink is mounted on the printed circuit board.
>
> Kehret et al. disclose at least one stiffener can be formed of plastic (column 6, lines 21, 37-41).
>
> It would have been obvious to one of ordinary skill in the art at the time the invention was made to use plastic to make the stiffener of Cromwell et al., as modified, as suggested by Kehret et al., for the purpose of reducing weight of the package assembly.

July 5, 2006 Office Action, p. 8.

Amended claim 12 now recites:

> 12. An improved Land/Ball Grid Array (L/BGA) integrated circuit assembly, comprising:
>
> a bolster plate;
>
> a printed circuit board (PCB) above the bolster plate;
>
> a L/BGA socket mounted on the PCB;

a L/BGA package mounted on and aligned with the L/BGA socket, the L/BGA package comprising:

a package substrate; and

a semiconductor chip mounted on the package substrate;

an elasto-plastic stiffener mounted on the package substrate of the L/BGA package, the elasto-plastic stiffener sharing a pressure with the semiconductor chip;

a frame mounted on the PCB and surrounding the L/BGA socket, the L/BGA package, and the elasto-plastic stiffener;

a heat transfer device mounted on the L/BGA package, the elasto-plastic stiffener, and the frame, wherein:

the assembly is secured with fasteners through the heat transfer device, the frame, the PCB, and the bolster plate so that a top surface of the L/BGA package have intimate contact with a bottom surface of the heat transfer device;

<u>the elasto-plastic stiffener is plastically deformed under the elasto-plastic stiffener's portion of the pressure to conform the elasto-plastic stiffener to vertical variations of elements above and below the elasto-plastic stiffener; and</u>

<u>the plastic deformation of the elasto-plastic stiffener defines an upper bound for the elasto-plastic stiffener's portion of the pressure, which in turn defines the semiconductor chip's portion of the pressure.</u>

Amended claim 12 (emphasis added).

Amended claim 12 recites a stiffener that shares a pressure with a semiconductor chip of package. The stiffener <u>plastically deforms</u> under the stiffener's portion of the pressure and conforms to vertical variations of a package. The plastic deformation also <u>sets a limit on the stiffener's portion of the pressure</u>. As explained above, this is because a material transfers substantially the same amount of force under plastic deformation. The limit on the stiffener's portion of the pressure also sets the semiconductor chip's portion of the pressure since the stiffener and the semiconductor chip share the pressure. This allows one to control the amount of pressure experienced by the semiconductor chip through the design of the stiffener.

Cromwell et al., Goodwin, and Kehret et al. do not disclose an elasto-plastic stiffener that plastically deforms as described above. Cromwell et al. does not disclose a stiffener. While

Goodwin discloses a pressure plate 60 between a heat sink 40 and a semiconductor device 10, it does not disclose that pressure plate 60 plastically deforms. While Kehret et al. discloses resilient plastic thermal interposers 224 between processors 214 and a heat spreader plate 240, Kehret et al. does not that thermal interposers 224 plastically deforms. Kehret et al. only states that "thermal interposers 224 are created from a resilient material which <u>is slightly compressed</u> to ensure a 'snug' fit for the electronic circuit 210 within top compartment 220." Kehret et al., col. 7, lines 60 to 62 (emphasis added). If anything, Kehret et al. teaches against plastically deforming any stiffeners by stating its thermal interposers 224 is <u>only slightly compressed (e.g., elastically deformed)</u>.

Applicant notes that the Examiner cited Kehret et al. because it discloses that thermal interposers 224 are made from a resilient plastic material. The Examiner apparently equated that with plastic deformation. As described above in the Background to Deformation, plastic deformation does not mean a material is made of plastic but rather it refers to a type of deformation experienced by the material that involves permanent shape change.

For the above reasons, amended claim 12 is patentable over Cromwell et al., Goodwin, and Kehret et al.

<u>Claims 1 and 5</u>

Applicant has amended claim 1 to depend from amended claim 12 and to include limitations similar to those found in dependent claim 5. Applicant has canceled claim 5. Accordingly, Applicant addresses the Examiner's rejection of claims 1 and 5 together.

The Examiner rejected claim 1 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,171,128 ("Huang et al."). Specifically, the Examiner stated that Huang et al. discloses "a laminate bonding layer applied on the insulative to fix the plurality of metal contact (figures 1-2 and 9) …." July 5, 2006 Office Action, p. 3. The Examiner rejected claim 5 under 35 U.S.C. 103(a) as being unpatentable over Huang et al. in view of U.S. Patent No. 4,161,346 ("Cherian et al."). Specifically, the Examiner stated that Cherian et al. discloses "a metal LGA socket contact (10, figures 1-3) … [that] is resilient in a vertical direction of an antigravity which is created by a chip package weight (48) when it is mounted thereon the socket contact." July 5, 2006 Office Action, p. 4.

Applicant has amended claim 1 to depend from amended claim 12. Amended claim 1 is now patentable over the cited references for at least the same reasons as amended claim 12. Furthermore, amended claim 1 is patentable over the cited references for the following reasons.

Amended claim 1 now recites that metal contacts each plastically deforms under a pressure to conform to vertical variations of elements above and below the socket. Amended claim 1 further recites the metal contacts in an elasto-plastic socket that plastically deforms to uniformly distribute the pressure.

Huang et al. only states that "base 2 having a plurality of conductive contacts 210 received therein …" and otherwise provides no details regarding conductive contacts 210. Huang et al., col. 2, lines 48 and 49. Cherian et al. discloses that its contacting element 10 can elastically deform but not plastically deform. "With top sides 36 extending free of the housing the element can absorb squeezing by the sandwiching boards without losing good electrical contact therewith, and without getting mechanically overstressed." Cherian et al., col. 3, lines 1 to 5 (emphasis added). If anything, Cherian et al. teaches against plastically deforming any metal contacts by stating its contacting element 10 is not mechanically overstressed (e.g., elastically deformed).

Amended claim 1 also recites an elasto-plastic socket that includes a laminate bonding layer applied on an insulative board to fix metal contacts inserted through the insulative board, which is not disclosed by Huang et al. and Cherian et al. The Examiner cited Figs. 1, 2, and 9 of Huang et al. to disclose the recited laminate bonding layer. However, Applicant cannot find the recited laminate bonding layer in Figs. 1, 2, and 9 and in their written description. Applicant respectfully requests the Examiner to clarify his statement or otherwise withdraw the rejection.

For the above reasons, amended claim 1 is further patentable over Huang et al. and Cherian et al.

Claims 2 to 4, 6 to 11, 14, 21 to 27

Claims 2 to 4, 7 to 10, 14, 21 to 27 depend from amended claim 12 and are patentable for at least the same reasons as amended claim 12.

Applicant has canceled claims 6 and 11, thereby rendering its rejection moot.

Summary

In summary, claims 1 to 14 and 21 to 26 were pending in the above-identified application when last examined. Applicant has amended claims 1 to 4, 7 to 10, 12, 14, and 21 to 26, canceled claims 5, 6, 11, and 13, and added claim 27. For the above reasons, Applicant respectfully requests the Examiner to withdraw the claim rejections and allow claims 1 to 4, 7 to 10, 12, 14, and 21 to 27. Should the Examiner have any questions, please call the undersigned at (408) 382-0480.

Respectfully submitted,

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